Analysis Of Childhood Asthma And Hazardous Emission Sites In Utah

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Objective

The objective of this study was to examine the effect of residential proximity to hazardous emission sites on the spatial and temporal variation of hospitalization rates for childhood asthma in four Utah urban counties (Weber, Davis, Salt Lake, and Utah).
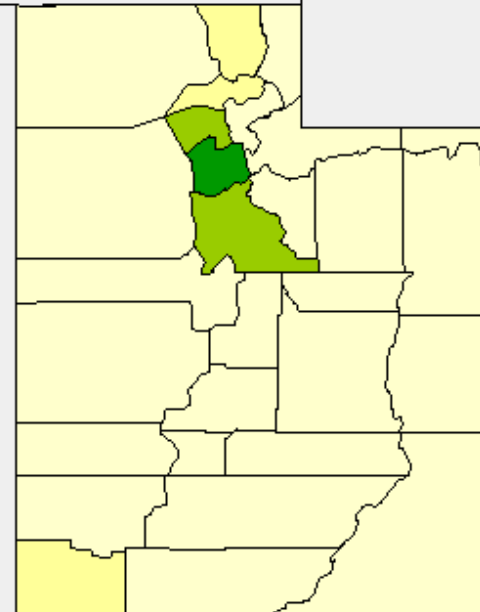
Methods

- The study area was defined as the four urban counties of Weber, Davis, Salt Lake and Utah County.

- 75.8% of Utah population lives in Salt Lake, Davis, Utah, & Weber Counties

Legend

Data classes

Total Persons

- 921 - 42745
- 90354 - 196533
- 238994 - 368536
- 898387 - 898387
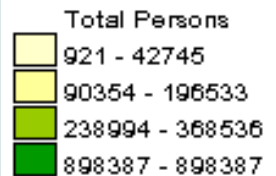
Total Persons, Utah by County
Census 2000

Prepared with American FactFinder.

Methods

- Asthma case data for children ages 0-14 years old admitted to the hospital during the study period (1990-1999) due to asthma (ICD-9-CM 493) were obtained from 14 hospitals in study area.

- Hospital admissions considered attributable to asthma were those with ICD-9-CM code 493 as the primary discharge diagnosis.

- The home address (at time of hospitalization) of each case was geocoded into a digital map using ArcView GIS Version 3.2.

- The birth address of each case (if born in Utah) was geocoded.

Methods

- The locations of the major sources of potential hazardous emissions within the study area were geocoded using ArcView.

- Hazardous emission sites included:
  - National Priorities List (NPL) sites;
  - Comprehensive Emergency Response, Compensation, and Liability Information System (CERCLIS) sites;
  - Resource Conservation and Recovery Act (RCRA) facilities;
  - Toxic Release Inventory (TRI) sites; and
  - Utah Division of Air Quality Point Source Emissions (PSE) sites.

Methods

- Rates of hospitalization for asthma in children ages 0 to 14 years of age were examined by year and census tract to determine whether the rates were increased because of residential proximity to hazardous emission sites from 1990 through 1999.
  - Annual incidence of children admitted to hospitals for asthma were calculated for each census tract.
  - Annual incidence rate was used to determine tracts with apparent excess risk for asthma using a Proportional Incidence Ratio (PIR).

- Geographic Information System (GIS) and spatial statistical methods were used to analyze the association of asthma clusters with the hazardous emission sites.

Hospital Admission Data

- Hospital admission data included:
  - name,
  - medical record number,
  - dates of admission and discharge,
  - home address at time of admission
  - Birth date
  - Gender
  - Mother's or father's name
  - Hospital name
  - ICD-9 diagnostic codes.

Birth Certificate Data

- Obtained from Utah Bureau of Vital Records and Health Statistics
- Birth addresses were available for 6,912 (60%) cases.
- Birth certificate data included:
  - Birth date
  - Gender
  - Race
  - Ethnicity
  - Birth location
  - Facility name
  - Mother's name
  - Mother's home address
  - Mother's use of tobacco and alcohol during pregnancy

Migration

- Proximity of the birth address to address at time of hospitalization was used as a measure of duration of exposure.

- Children whose birth address and event address were the same or very close were likely to have lived in the area for the full period between birth and hospitalization.

Geographic Information and Spatial Location

- Study period covered two census tract boundary structures: 1990 Census and 2000 Census

- Data standardized to the 2000 Census tract boundary data.

- Annual populations for years 1991 – 1999 were estimated using linear regression based on 1990 and 2000 census population data.

Geocoding Addresses

- Referential street and road data obtained from GDT Dynamap 2000 data set.

- Residential addresses for individuals at the time of birth (birth address) and addresses at time of hospital admission for asthma (event address) were geocoded using referential street and road data.

- Children admitted to the hospital for asthma were assigned to the census tract in which their event address was located.

Socioeconomic Indicators

- Socioeconomic data for each census tract were obtained from the U.S. Census Bureau for 1990 census.
- Socioeconomic Data:
  - Race
  - Ethnicity
  - Income
  - Education
  - Employment
  - Family size
  - Housing age
  - Housing value
  - Housing density
  - Population density

Income Categories

- 25 different income categories from census consolidated into three groups to facilitate analysis.
  - Less than $25,000 (1.3 times Utah poverty level)
  - $25,000 to $60,000
  - Greater than $60,000 (3.5 times Utah poverty level)

- Income stratification schema used in the National Health and Nutrition Examination Survey – III.

Housing Age

- Eight different categories of housing age from the census were consolidated into three housing age groups.
  - Houses built before 1946
  - Houses built between 1946-1973
  - Houses built after 1973

- Housing age categories used in the National Health and Nutrition Examination Survey-III.

Housing Value

- The 20 different housing value categories from the census were consolidated into 3 groups.

- Mean house value from 1990 census was $75,000.
  - Less than $50,000
  - $50,000 - $99,999
  - Greater than $100,000

Proximity to Environmental Hazards

- Number of hazardous emission sources per census tract was calculated to assess the ability of source counts per census tract to explain the incidence of children admitted to the hospital for asthma.

- Counts were standardized by census tract area.

Maternal Smoking

- Smoking and alcohol use of mother during pregnancy were obtained from birth certificates.

- Smoking data available on 4,378 (63.3%) of the 6,912 birth records.

- 948 (21.7%) indicated maternal smoking during pregnancy.

- Proportion of census tract birth records that indicated positive maternal smoking were analyzed by univariate binary logistic regression.

Maternal Alcohol Consumption

- Maternal alcohol consumption available on 4,373 (63.3%) of the birth records.

- 130 (3.0%) indicated maternal alcohol consumption.

- Proportion of census tract birth records that indicated positive maternal alcohol consumption were analyzed by univariate binary logistic regression.

Statistical Analysis

- Proportional Incidence Ratio (PIR):
  - The expected rate in each tract was the combined incidence rate of the remainder of the county.
  - The annual incidence rate of each census tract was compared with the annual expected incidence as a proportional incidence ratio (PIR).
  - Significantly elevated rate in a census tract was determined by the PIR greater than one and a lower 95% confidence limit greater than one.

Statistical Analysis

- Moran's I and Local Getis-Ord
    - Moran's I is a spatial autocorrelation test that tests for likeness of a spatial attribute (hospitalization rates) of a neighborhood (census tract) that has neighboring attributes. The Local Moran's I test identifies census tract incidence rates that contribute significantly to the likeness pattern.
    - Getis-Ord compares a neighborhood spatial attribute with neighboring attributes to identify clustering (either high or low) trends within the community of neighborhoods, and identifies those neighborhoods that have attributes that contribute signficantly to those trends.
    - A p-value of 0.05 in both tests and a positive z-value for the Getis-Ord test was used to differentiate census tracts with positive spatial autocorrelation for increased incidence rates.
    - SpaceStat 1.90 software

RESULTS

Incidence of Children Hospitalized for Asthma 1990 - 1999

- 16,028 asthma case records received.

- 4,527 (28%) excluded because no home address, located outside study area, or could not be geocoded.

- 11,501 records available for analysis

- Average annual incidence 43.6 cases/10,000 children, range of 0 to 1,400 cases per 10,000.

- National rate in 1993 was 28 children ages 0-14 years per 10,000.
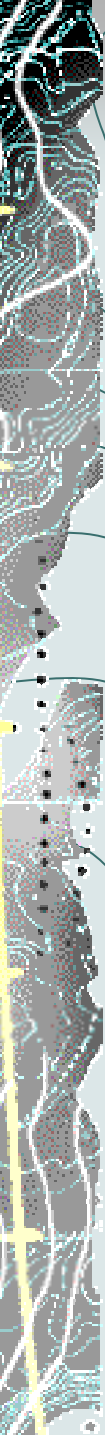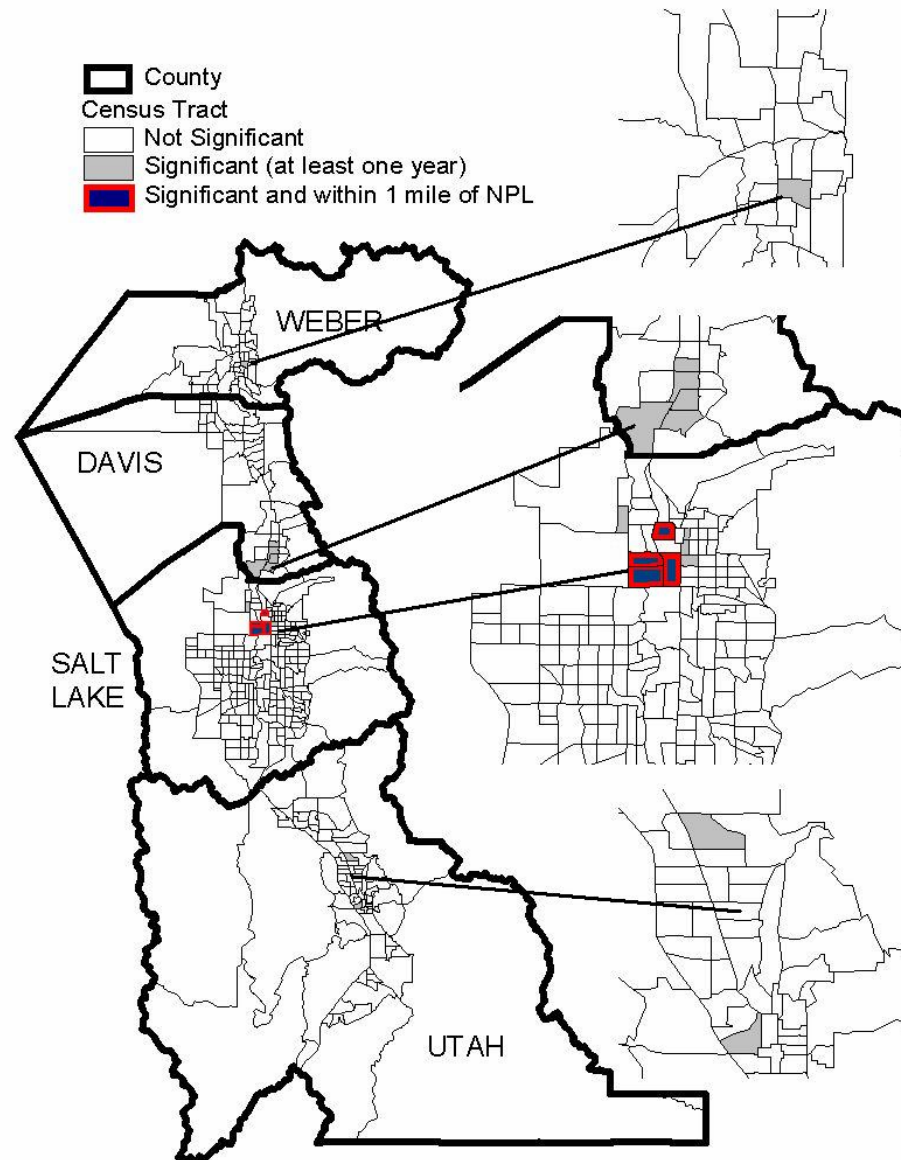
Spatial Analysis

368 census tracts evaluated

16 census tracts had significantly elevated numbers of children hospitalized for asthma.

13 census tracts formed two clusters in close proximity to each other.

- One cluster of 5 tracts in southern Davis County
- 2nd cluster of 8 tracts in northern part of Salt Lake County

County
Census Tract
Not Significant
Significant (at least one year)
Significant and within 1 mile of NPL

WEBER

DAVIS

SALT LAKE

UTAH

Spatial Analysis of the Distribution of Putative Sources

- 6,091 potential sources of hazardous emissions was analyzed for spatial association to census tracts with elevated rates of asthma.

- Hazardous emission sources included: 22 NPL sites, 197 CERCLIS sites, 1,659 RCRA facilities, 2,947 TRI sites, and 1,266 PSE sites.

- Spatial analysis of the distribution pattern of hazardous emission sources did not identify individual isolated sites that have causal relationships to elevated rates for hospitalization for asthma.

- Sites identified with spatial association were clustered around census tracts that had elevated incidence rates for asthma.

National Priority List (NPL) Sites
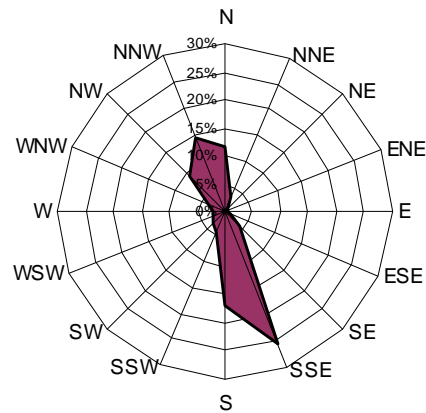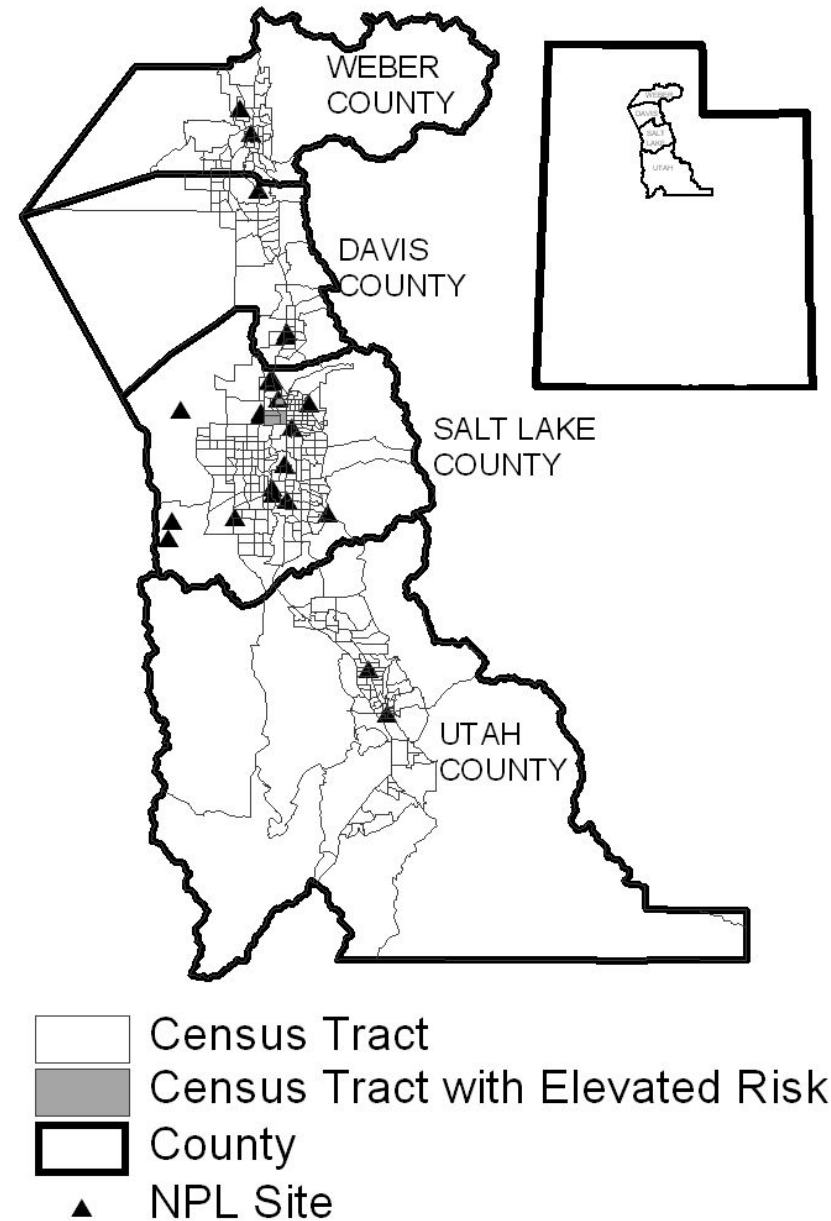
NPL SITES AND ASTHMA

- Four census tracts (1025,1028.01, 1028.02 and 1029) were within one mile of 3 NPL sites.
  - Portland Cement
  - Utah Power and Light/American Barrel
  - Wasatch Chemical Company
- Each NPL site contained contaminants that may exacerbate or cause asthma.

1025

1028.01

1029

1028.02

▲ NPL Site

☐ One Mile Radius

☐ Census Tract
▒ Census Tract with Elevated Incidence
☐ County
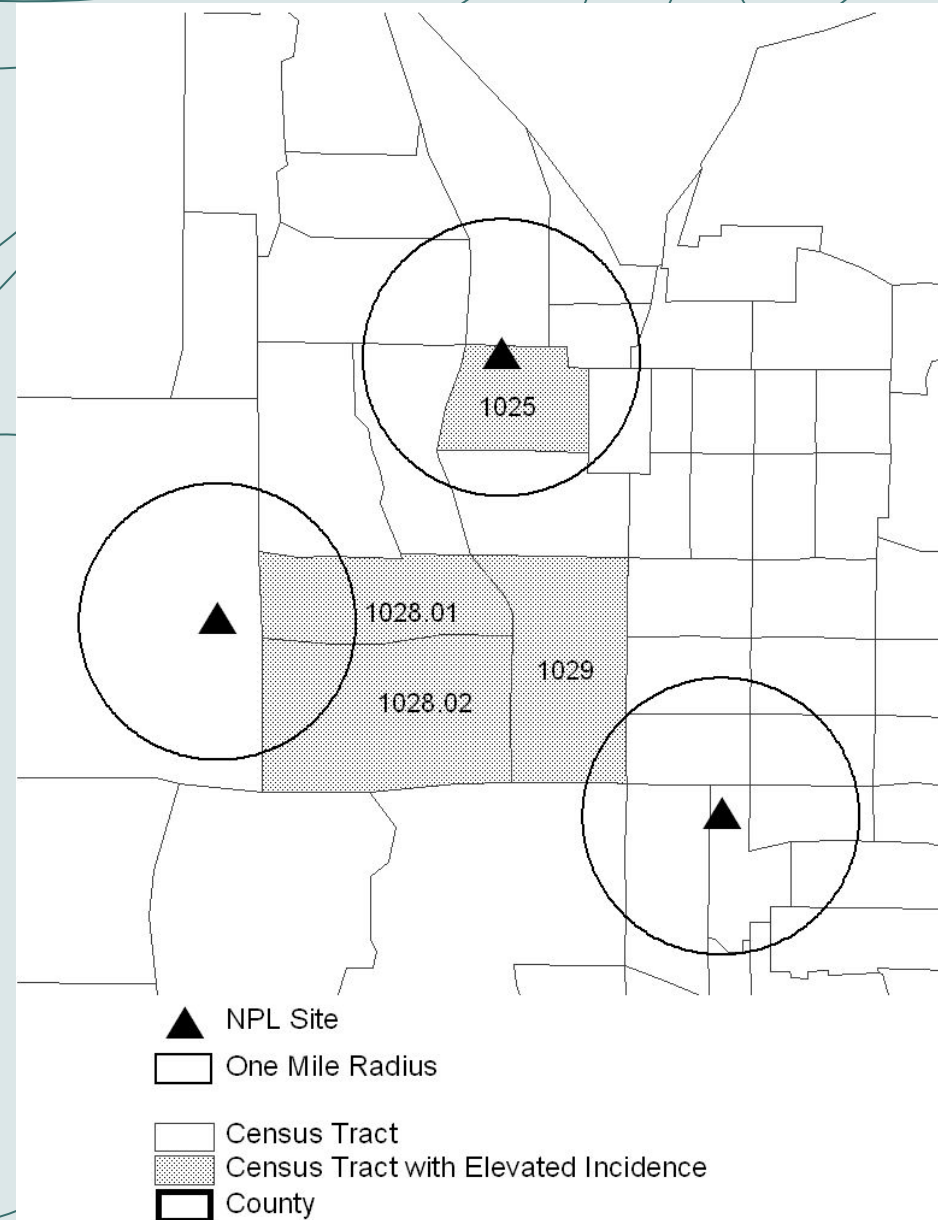
Proximity to Birth Address

- Birth addresses were available for 6,912 (60%) cases.
  - 2,600 (38%) birth addresses were within 100 meters of the corresponding event address
  - 2,940 (43%) birth addresses were within 1000 meters of event address.
  - 2,877 (42%) of birth addresses were within the same census tract as the event address.
- Approximately 26% of children evaluated during the study period had consistent environmental exposure from the time of birth to admission for asthma.
- Proximity of the event address to birth address was not a risk factor for elevated asthma rates in a census tract.

Proximity to Environmental Hazards

- The number of hazardous emission sources per area (density) within a census tract was a risk factor for increased rates for asthma hospitalization in a census tract.

- Number of CERCLIS sites within a census tract was a risk factor for increased rates in a tract.

Maternal Smoking and Alcohol Consumption

- Maternal smoking during pregnancy was found to be a risk factor associated with elevated rates of hospitalization for asthma in a census tract.

- Proportion of births in a census tract that indicated maternal alcohol consumption during pregnancy was not found to be a predictor of elevated rates.

Socioeconomic Factors

- Socioeconomic factors associated with increased childhood asthma hospitalization rates in these census tracts included low income, low education, and living in old, inexpensive housing.

- The predominance of housing built before 1949, predominance of housing valued less than $50,000 and small family size were the strongest predictors of increased asthma hospitalizations.

CONCLUSIONS

- Risks factors associated with census tracts that have elevated rates of children hospitalized for asthma:
  - Small families with low education level and low income who live in old, less-expensive housing are at the highest risk.
  - High density of hazardous emission sources in a census tract.
  - Maternal smoking during pregnancy.
- Study results suggest a possible use of ecologic methods to identify high-risk populations for asthma hospitalizations and using proximity to hazardous emissions sites along with socioeconomic and behavioral risk factors as predictors.
- Once the high-risk populations are identified, studies of individual risks are required to identify the most productive intervention activities for that population.

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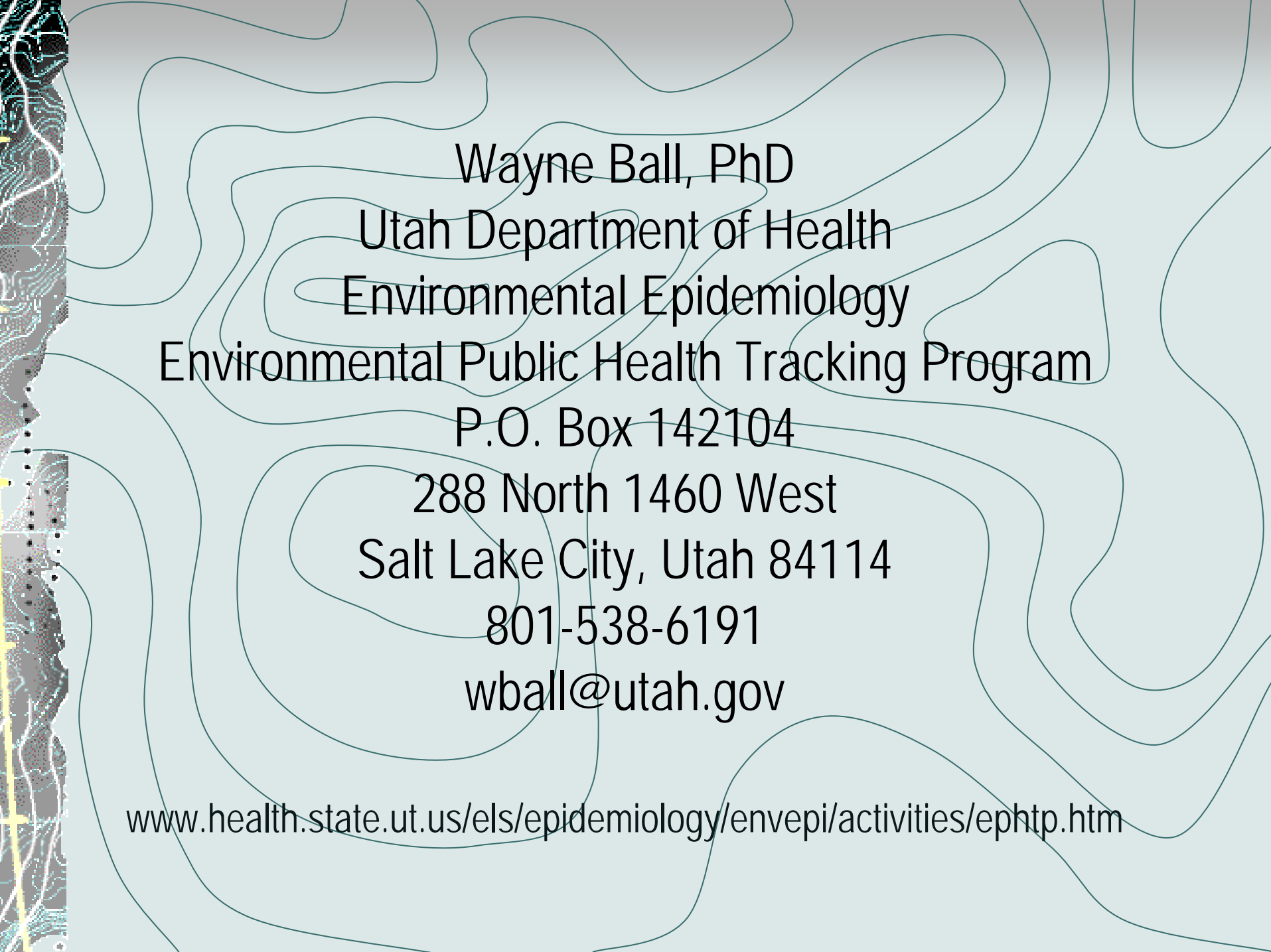Gambrelli Layco, Utah EPHTP Manager

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